XrdHTTP
HTTP and WebDAV for the Xrootd framework

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The XrdHTTP plugin

- XrdHTTP gives pragmatic HTTP(s) and WebDAV support to the XRootD framework
- Goal: take an already existing XRootD-based storage cluster and add the HTTP protocol
- Easy and cheap, no new HW required, no new daemons, no gateways, no scripts, no glue

- **HTTP/WebDAV for XrootD is done**
  - Support basic HTTP, DAV with a few DM extensions (replicas etc.)
  - Plug into the XRootD framework to rely on its features (e.g. tapes or monitoring) without reconfiguring the site or installing complex stuff
  - Can share the same port of the XRootD protocol. The client is automatically detected
  - Supports X509 auth, proxy certificates and VOMS extensions (*)
  - Any XRootD server will keep its advanced functionalities, PLUS HTTP compliance
  - Works on XRootD4, IPv6 compatible from the start
  - Expected to work on EOS
  - Done preliminary testing with Rucio, some minor fixes are done.

(*) Through an external plugin

Why HTTP/DAV?

- Interesting technical features
  - Multitalented, covers most existing use cases, while allowing new stuff
  - Applications just go straight to the data, wherever they are running
  - Staging (GET/PUT) or direct chunked access
  - Supports WAN direct access

- It's there, whatever platform we consider
  - HTTP is moving much more data than HEP worldwide, although in different ways
- We like browsers, they give a feeling of simplicity
  - Making people more open towards that technology
- Goes towards convergence
  - Users can use their preferred devices and apps to access their data
  - Sophisticated custom applications are allowed
  - Can more easily be connected to commercial systems and apps
- Attractive for a professional to be formed in these systems

HTTP and Grid computing

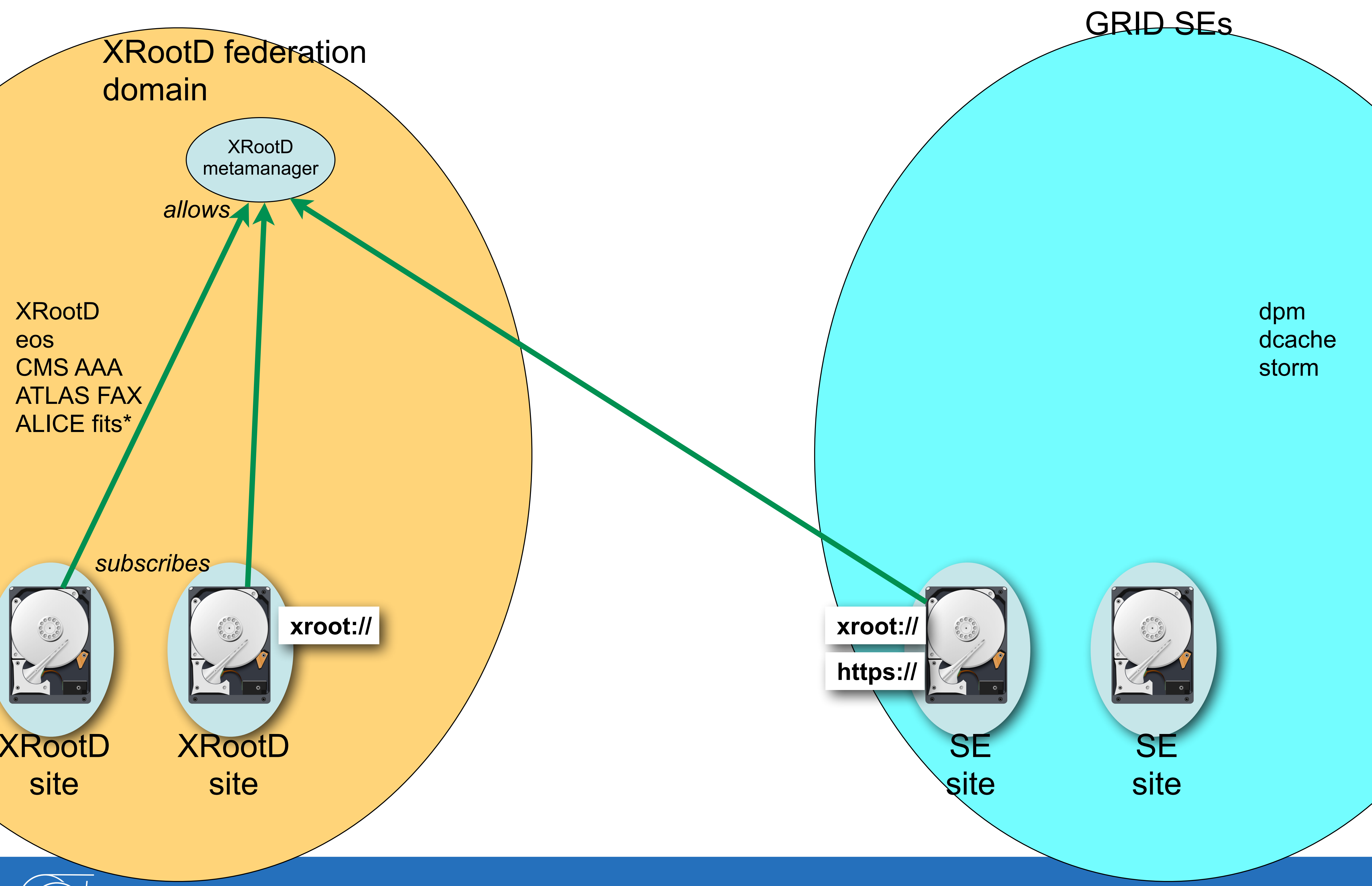
- We see potential in enabling HTTP and WebDAV for Grid data access

- For example, we may like to:
  - let browsers interact with Grid storage
  - let people use simple mainstream Web clients to do simple things
  - let people use advanced clients to get the full spectrum of features
  - let anyone write a Web interface (Java, Javascript) that interfaces Grid storage natively
  - Build integrations with Cloud services at the protocol level

HTTP and XRootD

- Many instances of XRootD, not only HEP
  - Generally high quality deployments of a high quality framework
  - Sometimes very important ones (e.g. CERN with EOS)
  - Advanced features: tapes, data movements, monitoring, etc.
  - This involves also many other components and groups of people using those hooks
    - Monitoring of the FAX is a perfect example
- Many instances of http/dav compliant SEs in the Grid
- Once a site/organization has chosen a framework, changing it can be very expensive
  - Also quality of service is at risk
- Risk is having islands of protocols within the same community

- How to fit XRootD-based SEs in a vision that allows HTTP ?


GRID SEs
XRootD federation
domain
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https://
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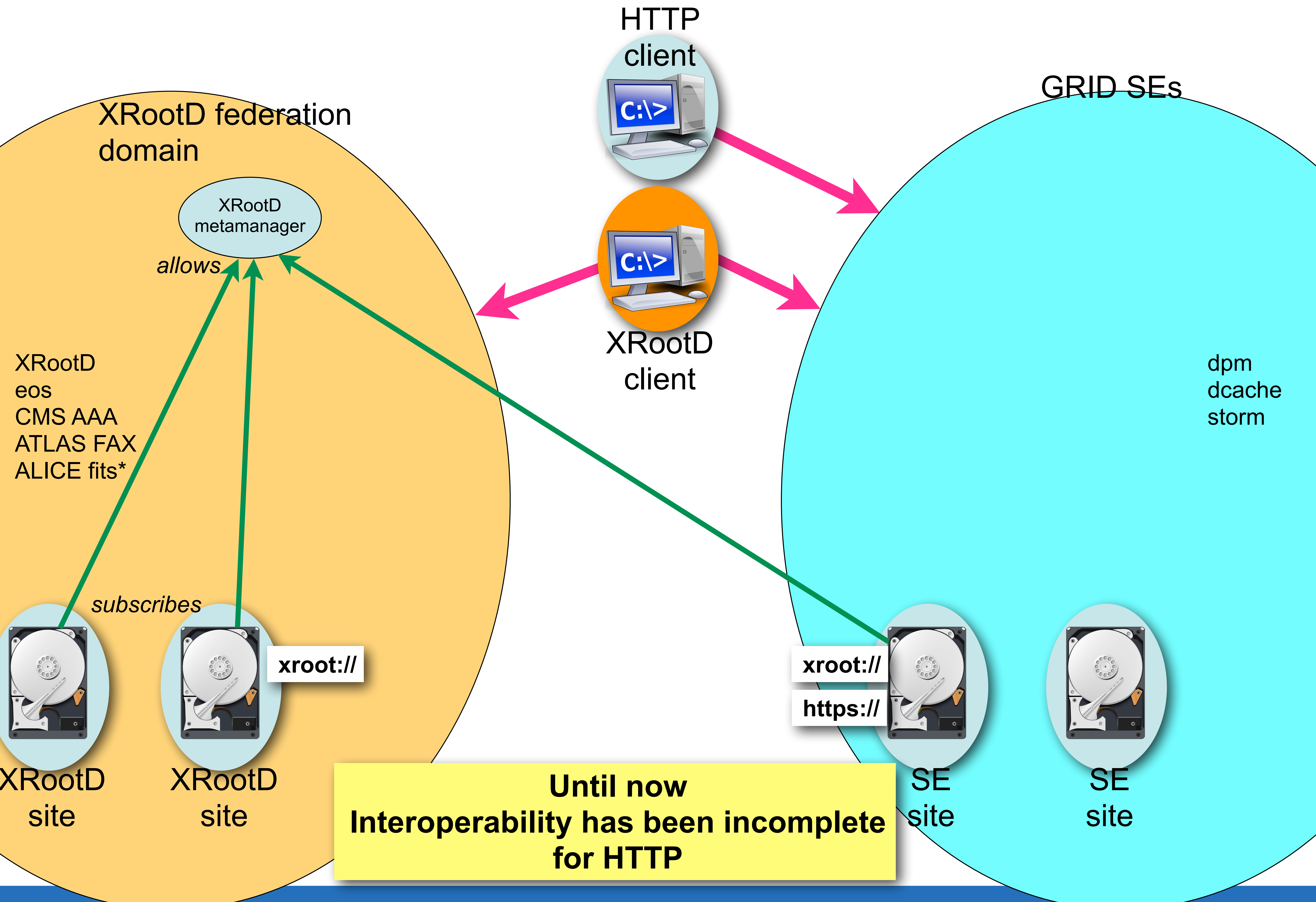
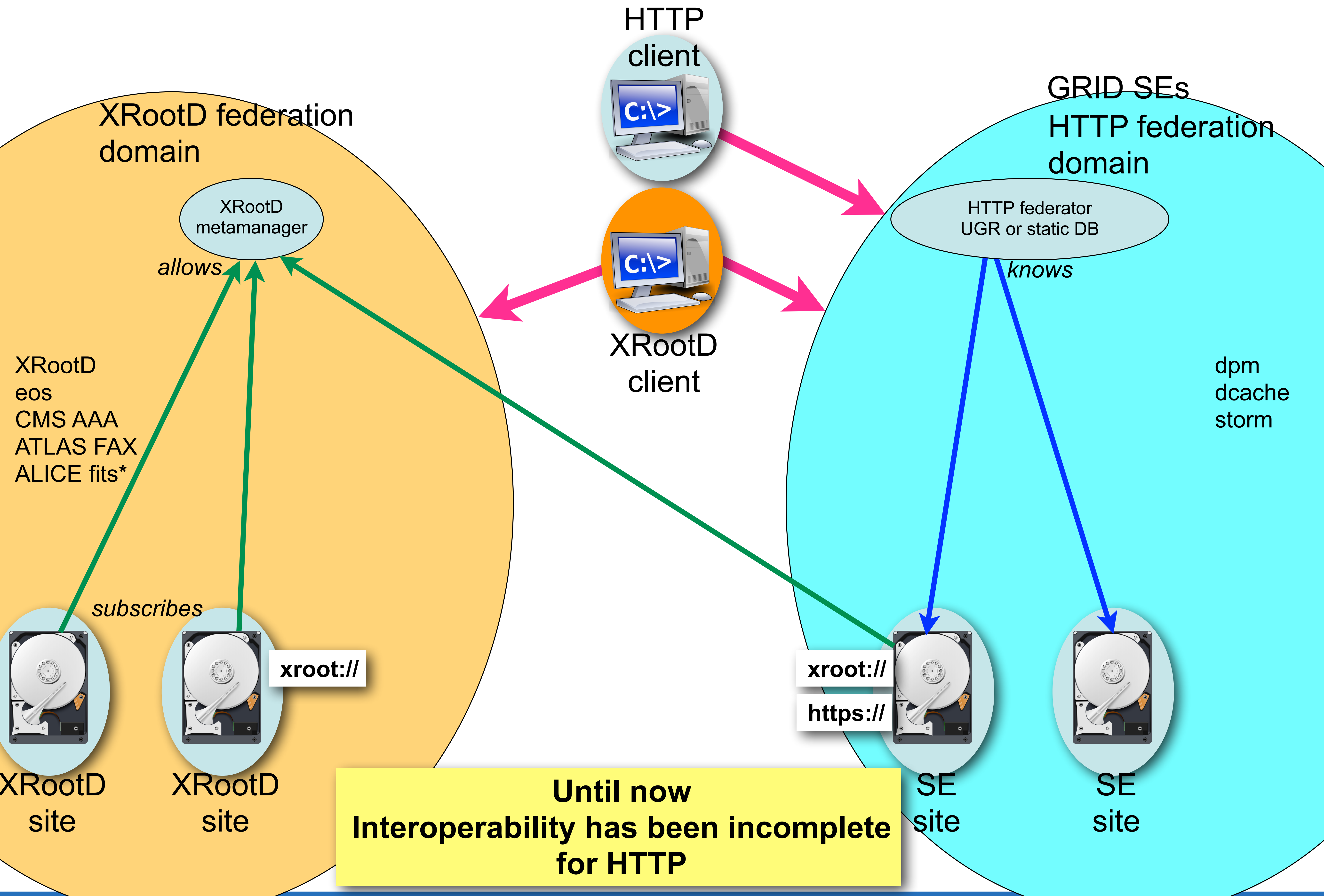


Until now
Interoperability has been incomplete for HTTP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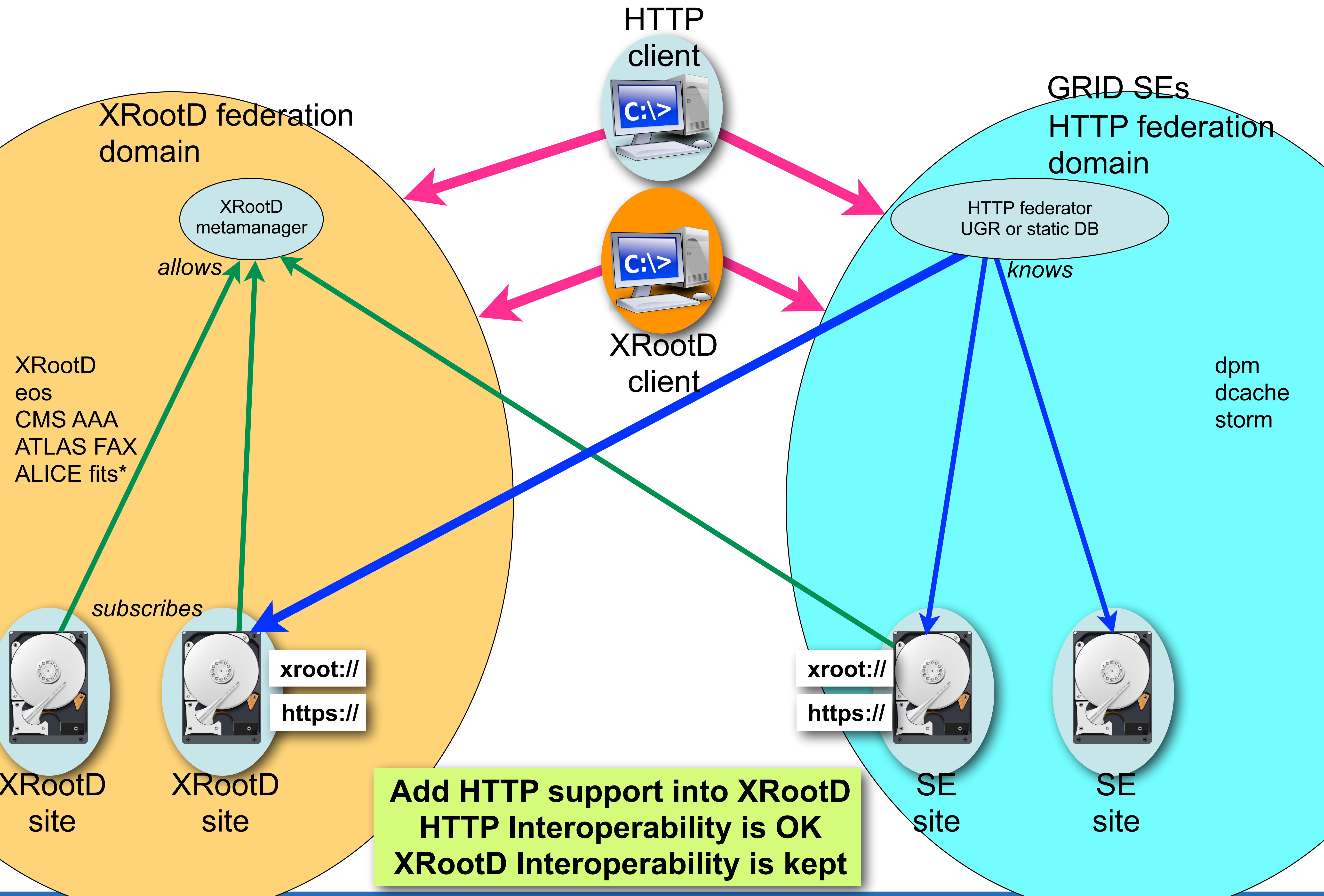
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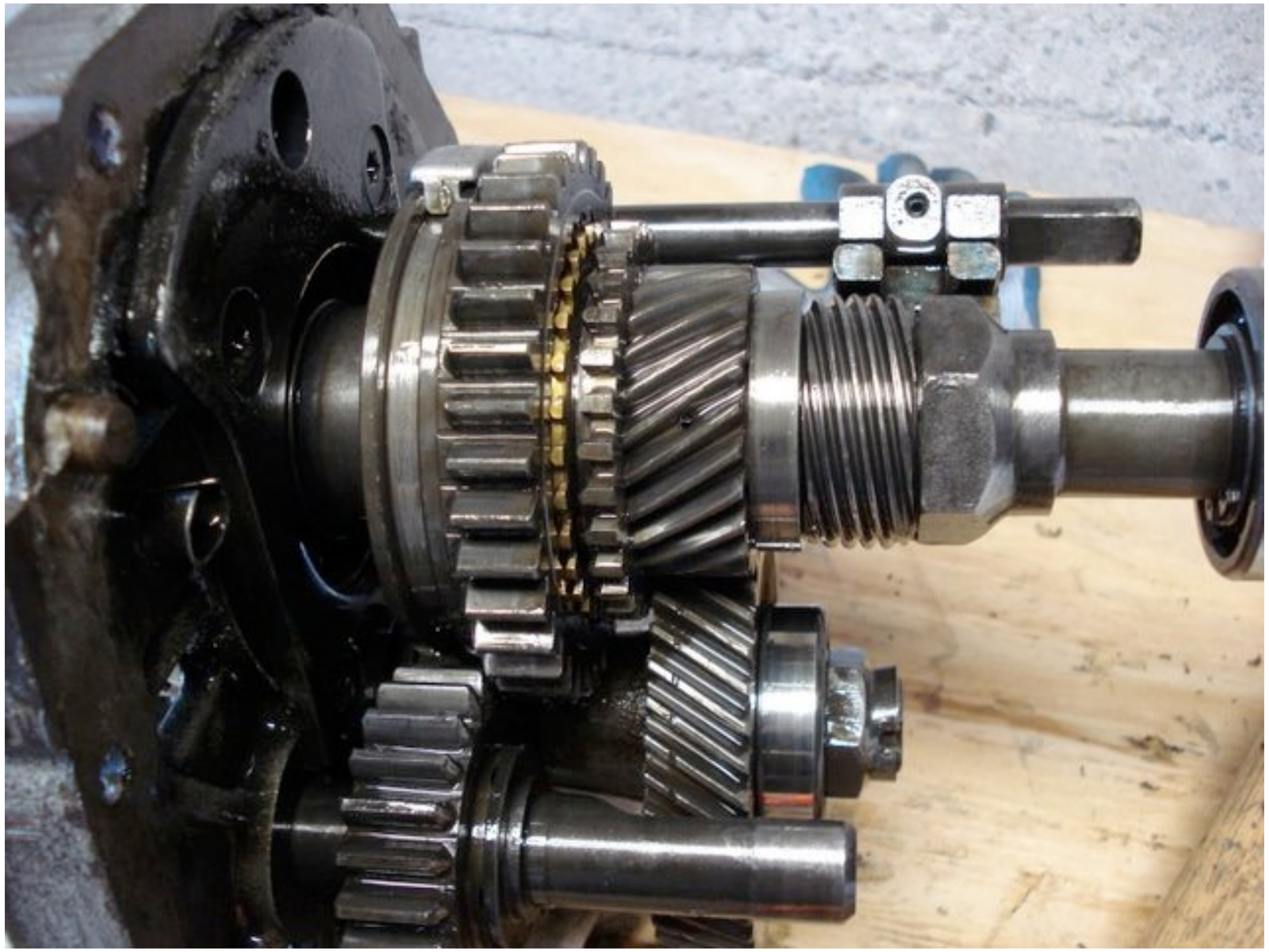
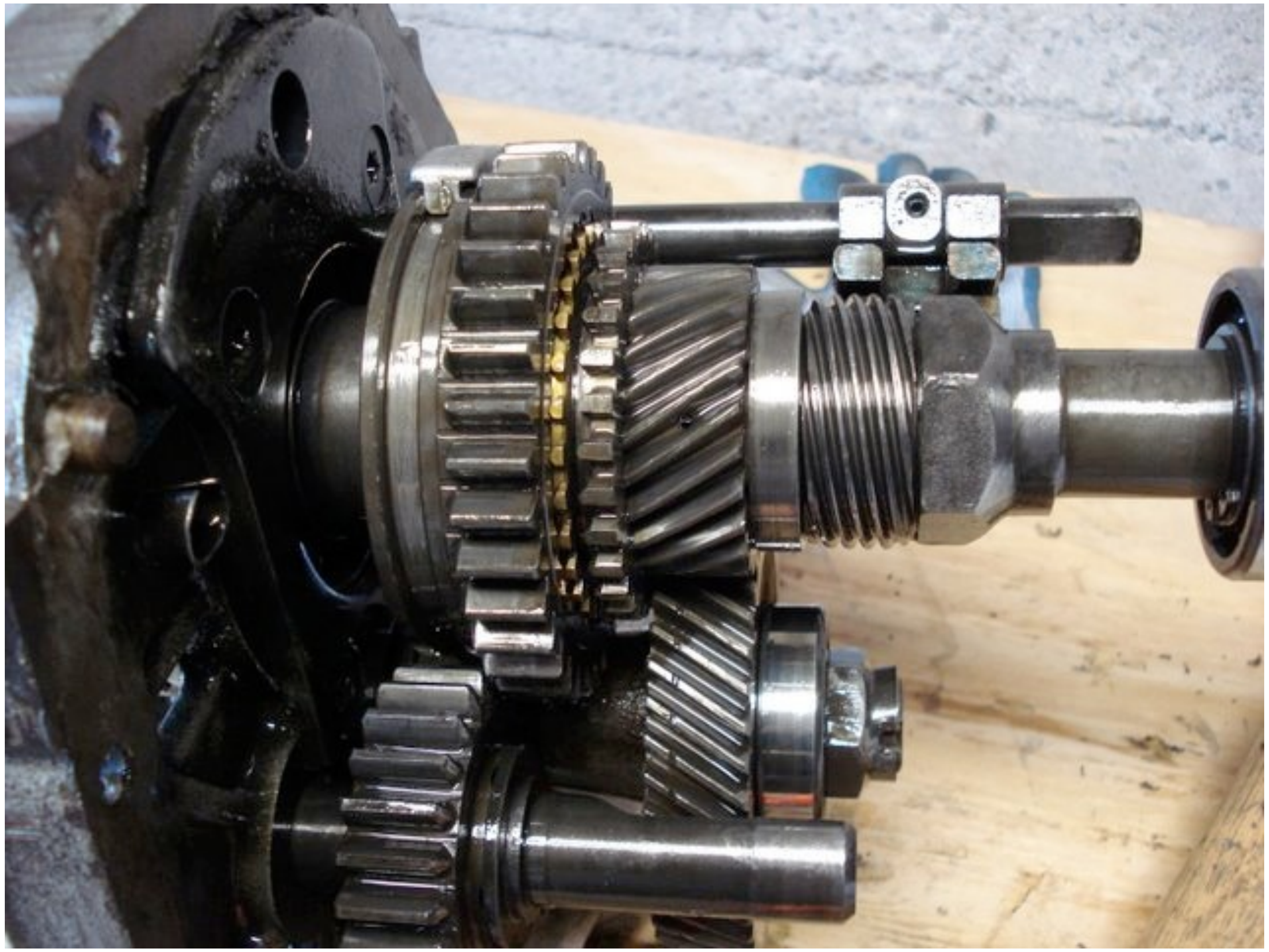
Add HTTP support into XRootD
HTTP Interoperability is OK
XRootD Interoperability is kept





How XrdHTTP works
Tech features explained

Supported primitives

- GET for files
- GET for dirs (HTML/CSS rendering)
- PUT
- PROPFIND (only at depth 1)
- HEAD
- OPTIONS
- MKCOL
- MOVE
- DELETE

GET and PUT: Chunk access

- GET supports Range headers
  - Single range to read scattered chunks one at a time
  - Multiple range, equivalent to a Vectored Read
  - ROOT TTreeCache works with XrdHTTP
    - Beware: TWebFile has issues, you must use TDavixFile (ROOT>5.34)

- PUT can only write whole files
  - No standard definition of ranges for PUT
  - Chunked write is not possible with PUT
  - Chunked write is called PATCH according to WebDAV
    - PATCH is not yet supported by XrdHTTP (nor by any server or client that I know)

Adding a protocol to Xrootd

- Always been possible to load different protocols implemented in so libraries e.g.
  - *XrdXrootd* --> gives what we call Xrootd
  - *XrdXProofd* --> gives the heart of PROOF
  - *XrdHTTP* --> gives HTTP and WebDAV

- The file access protocol *XrdXrootd* implements many sophisticated things: no-compromise I/O, monitoring, HSM, tape hooks, etc.
  - More than just the protocol semantics implementation
  - It's also the implementation of the features, i.e. high performance disk access, based on the low level functions of the Xrootd framework

- How to implement a new file access protocol (HTTP/DAV) without duplicating these difficult things?

The Xrootd Protocol Bridge

- *XrdBridge* allows to submit requests through memory to an *XrdXrootd* instance in use by the framework
  - The responses come through sync callbacks in the same process
  - This is a sort of internal in-memory gateway, giving xrootd protocol features to in-memory objects

- Hence the *XrdHttp* internal workflow is:
  - Manage the connection, detection, ssl, etc.
  - get the HTTP/DAV request header
  - get the security info from the connection (SSL, x509)
  - ask for more security info to specialized info extractors (VOMS)
  - translate HTTP/WebDAV requests into sequences of Xrootd requests
  - login into the Bridge passing the client's security credentials
  - inject the request into the *XrdBridge*
  - let *XrdBridge* handle autonomously the data chunks on the socket (= performance!)
  - collect the *XrdBridge* callback responses into a "response status"
  - Submit other partial *XrdBridge* requests OR craft the HTTP response (based on the current status of the request)

Xrd/HTTP/HTTPS Protocol detection

- We can configure XrdHTTP on any port, including the same port 1094 shared with the Xrootd protocol
  - **Hence, no need to reconfigure firewalls to add XrdHTTP**

- The Xrootd framework can run multiple protocols in the same TCP port
- The protocol implementations must be able to recognize their clients
- Note: HTTP and HTTPS live in the same port. Once a connection is given to XrdHTTP, it applies some heuristics to discriminate between http/https
- Basically "if it's not an ASCII HTTP request then try with SSL, otherwise fail"
- Works well!

Performance on header parsing (1/2)

- HTTP headers have not been designed with performance in mind. Well known story that will be fixed by http2
- XrdHTTP was designed to maximize the efficiency in reading/parsing the HTTP request headers
- Still it requires parsing, using a bit more CPU than the xrootd protocol
- Header ends with a double CRLF
  - Historical annoyance for performance
  - The problem: How to read from a stream, efficiently looking for a double CRLF
- The lazy student's solution… get 1 char at a time from the socket? Serious?
  - That would give internal latency and horrible CPU waste

Performance on header parsing (2/2)

- The XrdHTTP recipe:
  - Read as many bytes as possible from the socket in chunks as large as possible
    - Minimize the calls to read() and poll()
  - A circular buffer (hundreds of Ks) with efficient "readline" primitives
    - Virtually unlimited max header size (good for composite ops or crazy headers, cookies, etc.)
    - Max line length is the whole buffer
    - Allows code to be pedantic against buffer overflow attacks
  - If the buffer has read from the link past the double CRLF, *XrdBridge* can be injected (if needed) the remainder data read that is not part of the already processed header

Clustered setup

- Load XrdHTTP in a data server and we have an HTTP/DAV endpoint
- Load XrdHTTP in an xrootd manager and we have an XrdHTTP redirector
- A redirector follows the regular Xrootd redirection semantics,
  - Redirectors will try to redirect clients on all the primitives
  - Hence, client apps need to coherently process redirections for all the HTTP/DAV primitives to support XrdHTTP clustered operations
    - (Or other objects have to act as HTTP gateways)

Client support

- *libCurl, wget, libneon, cadaver,* etc…
  - These all work according to their limits
    - E.g. In the case of sophisticated things the app may have to interpret the redirect responses that they would return unprocessed
  - The typical cases of simple access work well
- Browsers just work, listings are rendered to HTML
- The client that we contributed is Davix
  - Fedora, EPEL, Solaris, Debian, Windows
  - http://dmc.web.cern.ch/projects/davix/home
- TDavixFile on ROOT 5.34 and ROOT 6
  - About to appear in the LCG releases
- Everyone if free to design some fancy HTML/Java/ Javascript interface

XrdHTTP Basic Configuration

- All the flavors with very few statements
- Basic server with HTTP/HTTPS/DAV/DAVS:

```
if exec xrootd
   xrd.protocol XrdHttp /usr/lib64/libXrdHttp.so.1
fi

# Drop these for an open plain HTTP/DAV server
http.cert /etc/grid-security/hostcert.pem
http.key /etc/grid-security/hostkey.pem
http.cadir /etc/grid-security/certificates

... inserted into an existing config file
```

- Will work also for redirectors
- We can do better though, avoiding that HTTPS clients do the sec handshake twice
  - Once with the redirector + once with the data server
- Moreover, HTTPS data servers will be slower

Clustered security configuration (1/2)

- *plain http://* ... everything unencrypted, no security
- *full https://* ... secure auth, secure redir, secure data xfers
  - The default when certs are configured
  - HTTPS handshakes happen in both redirector and data server

- *https-to-http with security token* :
  - secure authentication, HTTPS->HTTP redir to data server with encrypted security token, http data xfers
  - HTTPS handshakes will happen in the redirector only

- *http-to-https*
  - HTTP->HTTPS to secure data servers
  - HTTPS handshakes will happen in the data server only (= distributed)
  - HTTPS data transfers in the data servers ... may mean higher load and more latency

- *http-to-https-to-http with security token*
  - HTTP->HTTPS redir, HTTPS auth, HTTPS->HTTP redir to the same host with security token, plain data xfers
  - The HTTPS handshakes are distributed in the data servers

Clustered security configuration (2/2)

- Configuring certs and CAs tells to a server that it has to support https
- Tell if the redir destination is http or https

```
# If this server needs to redirect, we may want to choose if
# to redirect with http or https
http.desthttps no|yes
```

- Simple Shared Secret encrypted tokens to carry auth information through plain HTTP redirection

```
# The key that has to be shared between HTTP redirectors and servers in this
#  cluster. The minimum length is 32 characters, hence the default
#  one will not work.
# A data server with the secret key set will only accept
#  - requests that have been correctly hashed
#  OR
#  - requests using https (if https is configured)
http.secretkey CHANGEME_MINIMUM32CHARS
```

VOMS support

- XrdHTTP implements HTTPS authentication and X509
- It extracts auth data from the SSL connection and passes it to the Xrd framework for normal authorization processing
- XrdHTTP can load an additional “Security Extractor” plugin that can amend this information before it is submitted to the rest of the Xrd framework
- We wrote a VOMS security extractor plugin
- No other config beside loading it

```
http.secxtractor /usr/lib/libXrdHttpVOMS.so
```

- NOTE: due to the dependency towards libVoms2, this plugin is not shipped with XrdHTTP inside the Xrootd sources
- We will make it available when Xrootd4 is released in EPEL

Clusters, clients and file listings (1/2)

- An xrootd data server can only provide the listings for the files it contains
- An xrootd redirector does not provide any listings, just redirections!

- The native xrootd client works around this, and to collect a listing it crawls the cluster, querying all the servers
- A generic HTTP or DAV client cannot do that, the listing must come from a single place

- Web browsers are implicitly connected to the idea of listings. Not having them would be very questionable!
- Web browsers mean interactivity. The listings must be quick or the user experience will be disappointing.

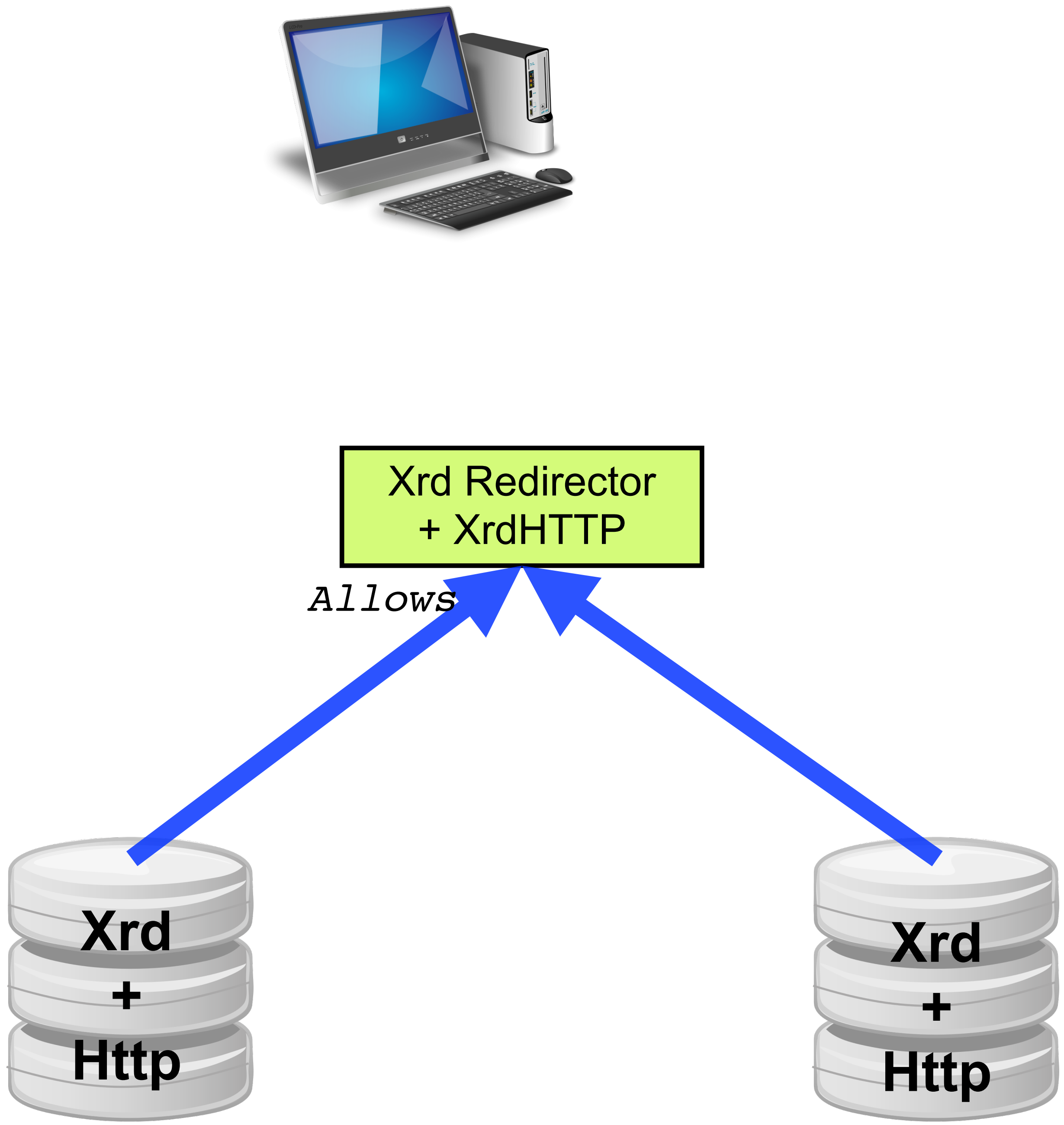
- A single XrdHTTP data server will just work.
- A cluster with XrdHTTP support can redirect PROPFIND and GET (for directories) to an external system that knows how to provide quick listings

```
# Redirect on listing request. Client must support redirs!
http.listingredir http://mynewhostwhichprovideslistings:80/
```

- then… how to provide quick listings for many users and vast metadata repos?

Clusters, clients and file listings (2/2)

- We have successfully evaluated the Dynamic Federations to provide those listings for a cluster
  - Speed and scalability in collecting metadata on-the-fly
  - See the other presentation on the Dynafeds and the Ugr (Uniform Generic Redirector)



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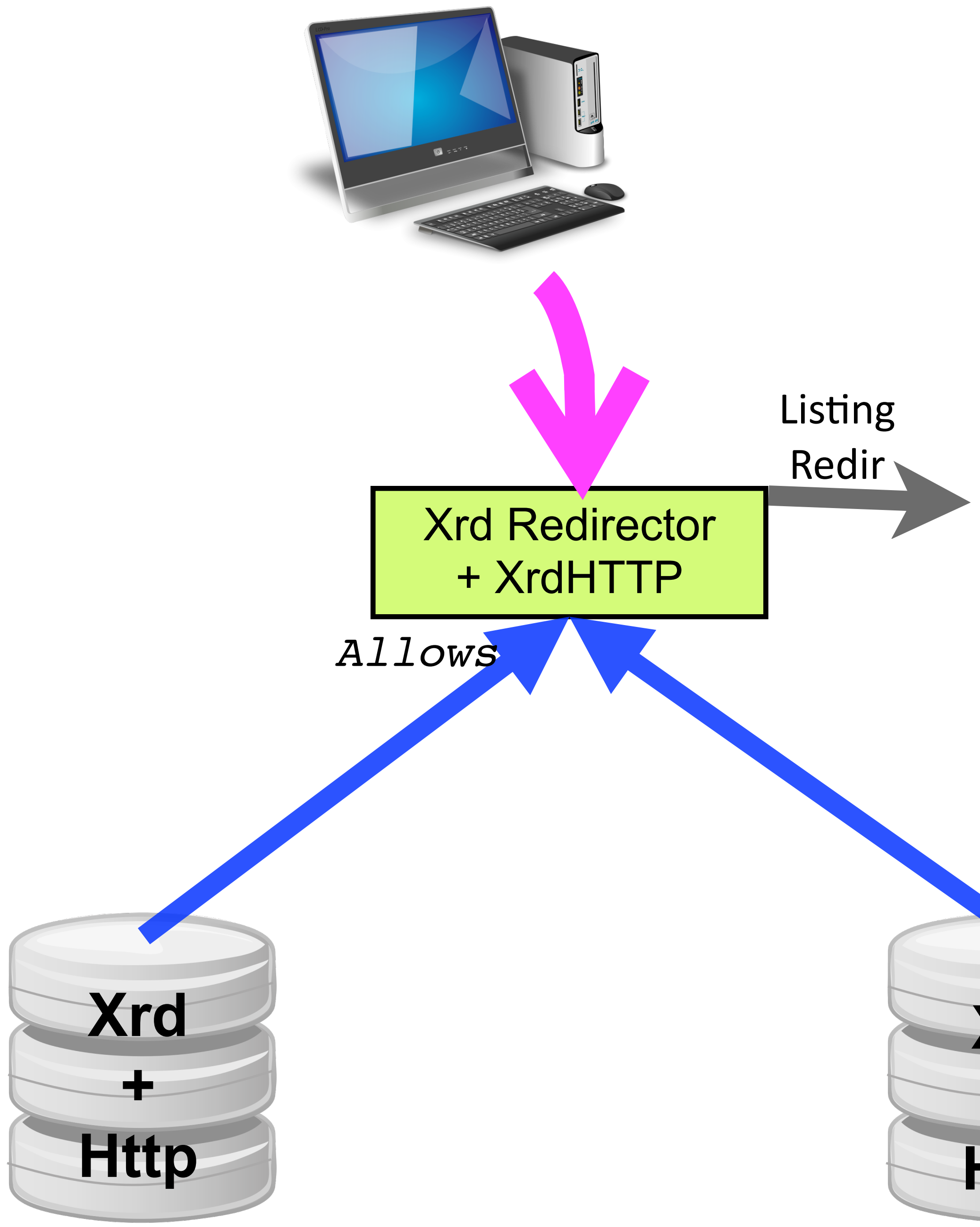

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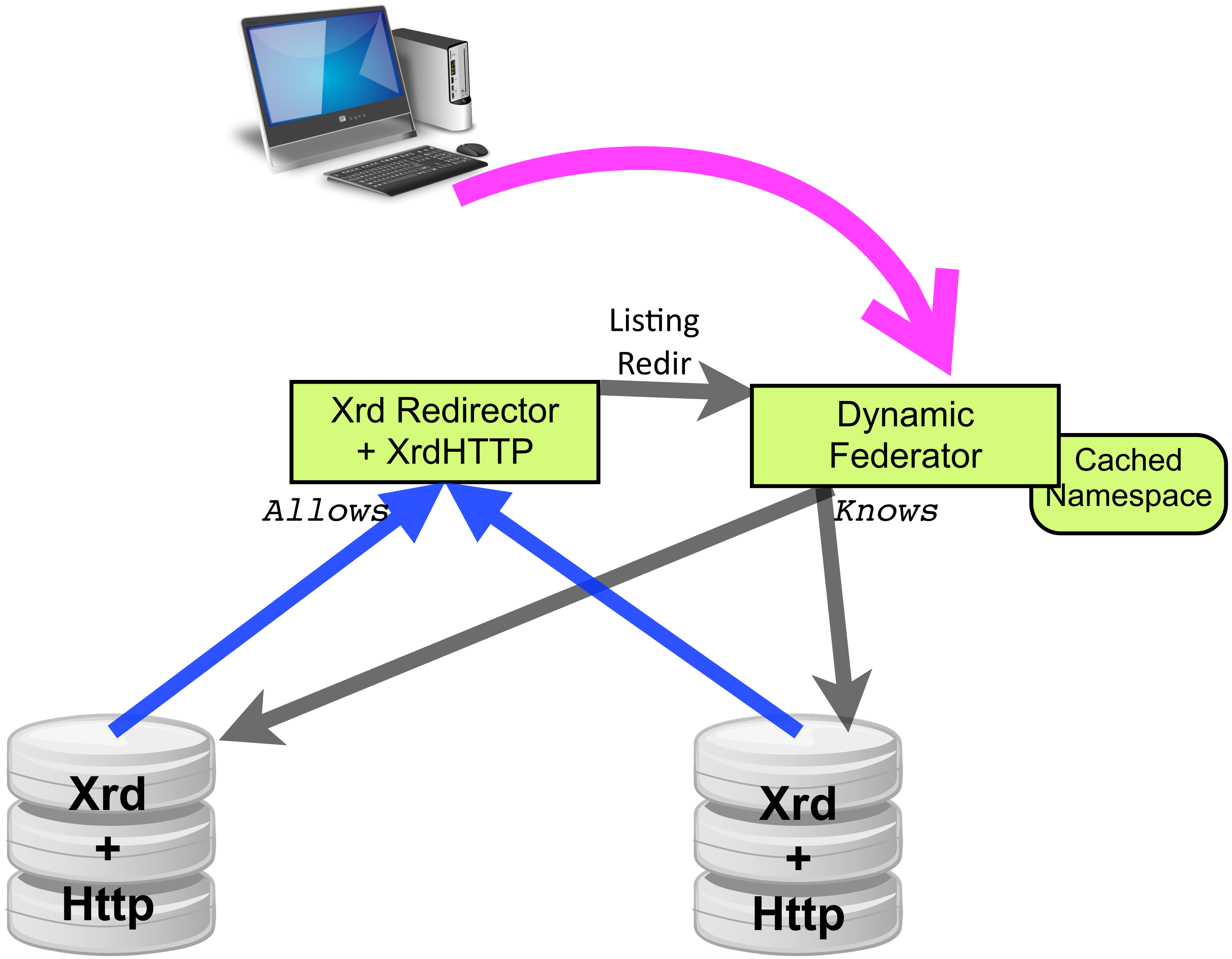

The HTTP ecosystem for HEP

- **DPM**
- dCache
- STORM
- **HTTP for XRootD**
- **HTTP Federations**
- **FTS3**
- **DAVIX**
- **ROOT with TDavixFile**

- We want seamless interoperability, which is more than coexistence
- Performance and ability to compose services
- Any standard client will work and give its features
- Our contribution “fills the gaps” between plain Web and HEP data access
- Browsers are supported
- An advanced client will give all the features (implemented using standards)

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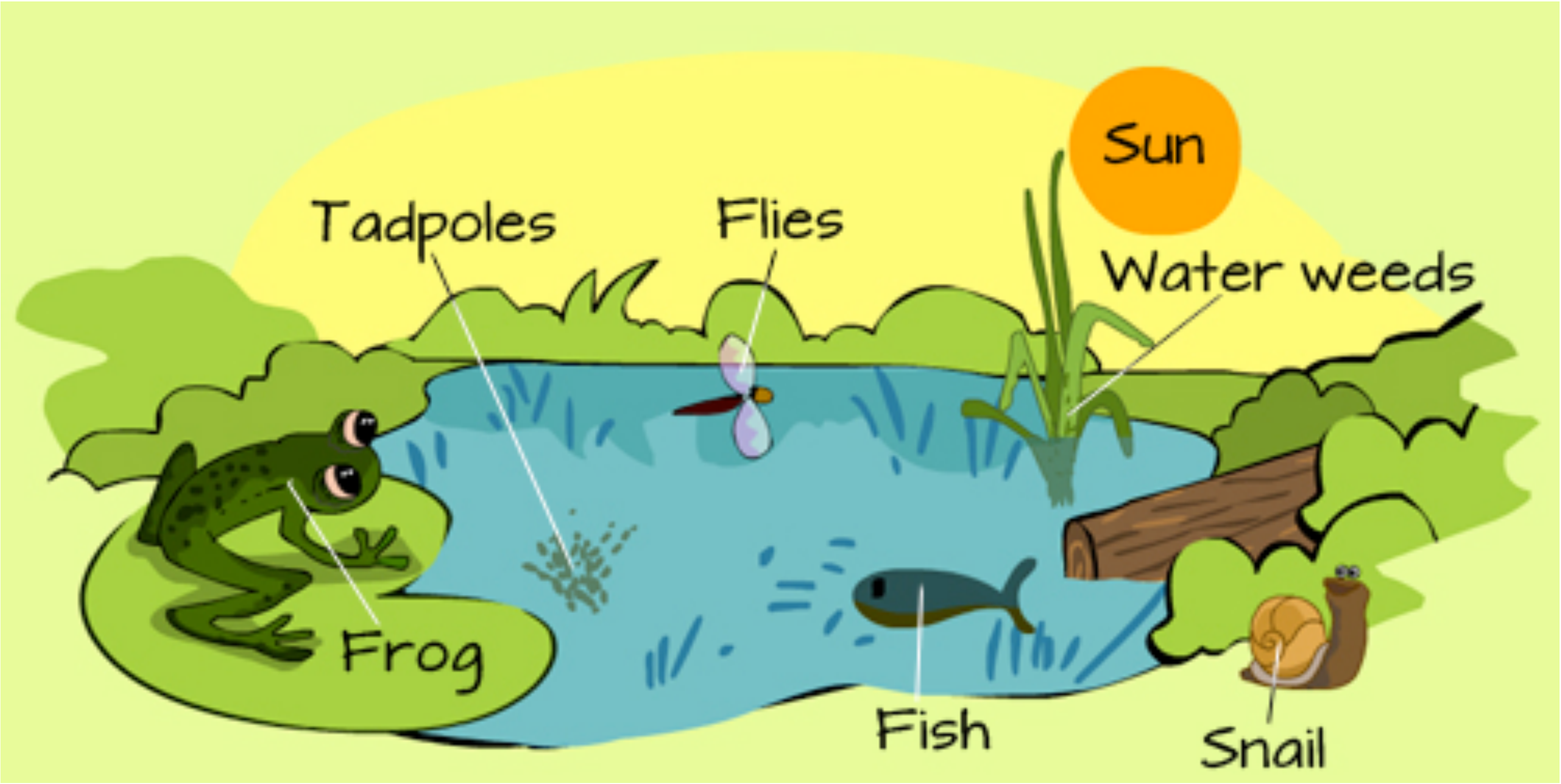

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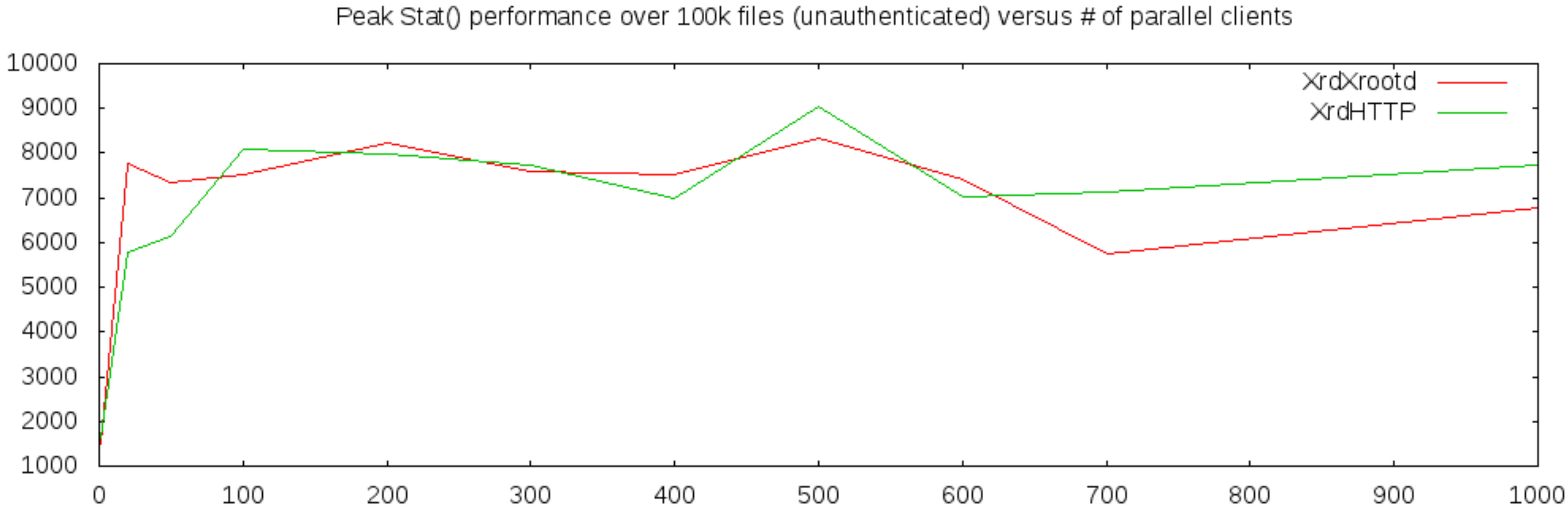
A little benchmark

- No big differences xrootd/Http were expected. The xrootd framework handles all the raw data exchanges, threading and polling. Both proto implementations are efficient.
- For large files/chunks we see no difference, unless the data encryption is used (which the xrootd protocol does not support, but HTTPS does)
- For metadata operations we expected to see a slightly higher CPU usage (~5-10%), depending on the kind of pattern
- Actually seeing it or measuring its effect is not that straightforward, as in the following example, that was supposed to be a difficult test. They perform basically the same at 7K stats/sec



Conclusion

- XrdHTTP is our contribution for the Xrootd framework to be accessible with HTTP/WebDAV tools
  - Comes with Xrootd4
  - XrdHttpVOMS will come after the EPEL release of Xrootd4
- Opens new scenarios headed to compatibility
  - Interactive things, browsers, clouds, ...
- Preserves the existing features of the Xrootd framework
- Does not interfere with the activity done through the Xrootd protocol
  - Can share the same port 1094, no firewall changes, both protocols work together
- Low overhead
- Low config/management overhead